Cancel 3

setting a mixing ratio of a silicon-containing gas and other raw material gases during said vapor phase epitaxy at a desired value in a range which increases substantially in proportion to a conductivity (1/resistivity) of said gallium nitride group compound semiconductor so as to control conductivity (1/resistivity) of said gallium nitride group compound semiconductor at a desired value; and

forming said gallium nitride group compound semiconductor by feeding said silicon-containing gas and other raw material gases at a mixing ratio set above.

20. A method for producing a gallium nitride group compound semiconductor by using an organometallic compound vapor phase epitaxy, comprising the steps of:

setting a mixing ratio of a silicon-containing gas and other raw material gases during said vapor phase epitaxy at a desired value in a range which increases substantially in proportion to an electron concentration of said gallium nitride group compound semiconductor so as to control a carrier concentration of said gallium nitride group compound semiconductor at a desired value; and

forming said gallium nitride group compound semiconductor by feeding said silicon-containing gas and other raw material gases at a mixing ratio set above.

21. A method for producing a gallium nitride group compound semiconductor according to claim 19, wherein said gallium nitride group compound semiconductor is $Al_xGa_{1-x}N$ ($0 \leq x \leq 1$).

22. A method for producing a gallium nitride group compound semiconductor according to claim 20, wherein said gallium nitride group compound semiconductor is $Al_xGa_{1-x}N$ ($0 \leq x \leq 1$).

C3 Cont'd.

23. A method for producing a gallium nitride group compound semiconductor according to claim 19, wherein said gallium nitride group compound semiconductor is GaN.

24. A method for producing a gallium nitride group compound semiconductor according to claim 20, wherein said gallium nitride group compound semiconductor is GaN.

25. A method for producing a gallium nitride group compound semiconductor according to claim 19, wherein said conductivity (1/resistivity) is not less than 3.3/Ωcm.

26. A method for producing a gallium nitride group compound semiconductor according to claim 21, wherein said conductivity (1/resistivity) is not less than 3.3/Ωcm.

27. A method for producing a gallium nitride group compound semiconductor according to claim 23, wherein said conductivity (1/resistivity) is not less than 3.3/Ωcm.

28. A method for producing a gallium nitride group compound semiconductor according to claim 20, wherein said electron concentration is not less than $6 \times 10^{16}/cm^3$.

29. A method for producing a gallium nitride group compound semiconductor according to claim 22, wherein said electron concentration is not less than $6 \times 10^{16}/cm^3$.

30. A method for producing a gallium nitride group compound semiconductor according to claim 24, wherein said electron concentration is not less than $6 \times 10^{16}/cm^3$.

31. A method for producing a gallium nitride group compound semiconductor according to claim 19, wherein said conductivity (1/resistivity) is ranging from 3.3/Ωcm to 1.3 x 10^2/Ωcm.

32. A method for producing a gallium nitride group compound semiconductor according to claim 21, wherein said conductivity (1/resistivity) is ranging from 3.3/Ωcm to 1.3 x 10^2/Ωcm.

33. A method for producing a gallium nitride group compound semiconductor according to claim 23, wherein said conductivity (1/resistivity) is ranging from 3.3/Ωcm to 1.3 x 10^2/Ωcm.

34. A method for producing a gallium nitride group compound semiconductor according to claim 20, wherein said electron concentration is ranging from 6 x 10^{16}/cm^3 to 3 x 10^{18}/cm^3.

35. A method for producing a gallium nitride group compound semiconductor according to claim 22, wherein said electron concentration is ranging from 6 x 10^{16}/cm^3 to 3 x 10^{18}/cm^3.

36. A method for producing a gallium nitride group compound semiconductor according to claim 24, wherein said electron concentration is ranging from 6 x 10^{16}/cm^3 to 3 x 10^{18}/cm^3.

Cont'd.

37. A method for producing a gallium nitride group compound semiconductor according to claim 19, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

38. A method for producing a gallium nitride group compound semiconductor according to claim 20, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

39. A method for producing a gallium nitride group compound semiconductor according to claim 21, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

40. A method for producing a gallium nitride group compound semiconductor according to claim 22, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

41. A method for producing a gallium nitride group compound semiconductor according to claim 25, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

42. A method for producing a gallium nitride group compound semiconductor according to claim 28, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

Cont'd.

43. A method for producing a gallium nitride group compound semiconductor according to claim 31, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

44. A method for producing a gallium nitride group compound semiconductor according to claim 34, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

45. A method for producing a gallium nitride group compound semiconductor according to claim 37, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

46. A method for producing a gallium nitride group compound semiconductor according to claim 38, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

47. A method for producing a gallium nitride group compound semiconductor according to claim 39, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

C3 Contd.

48. A method for producing a gallium nitride group compound semiconductor according to claim 40, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

49. A method for producing a gallium nitride group compound semiconductor according to claim 41, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

50. A method for producing a gallium nitride group compound semiconductor according to claim 42, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

51. A method for producing a gallium nitride group compound semiconductor according to claim 43, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

52. A method for producing a gallium nitride group compound semiconductor according to claim 44, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

C3 Contd. Sheet

53. A method for producing a gallium nitride group compound semiconductor by an organometallic compound vapor phase epitaxy, comprising the steps of:

setting a supplying rate of silicon (Si) to gallium (Ga) in a reaction chamber during said vapor phase epitaxy at a desired value in a range from 0.1 to 3 as a converted values so as to control a conductivity (1/resistivity) of said gallium nitride group compound semiconductor at a desired value, where said values 0.1 and 3 are the values obtained from gas flow rates, in case that an amount of said gallium (Ga) is converted into a flow rate of hydrogen bubbling trimethyl gallium (TMG) at a temperature of -15°C and an amount of said silicon (Si) is converted into a flow rate of a gas diluted to 0.86 ppm.

54. A method for producing a gallium nitride group compound semiconductor by an organometallic compound vapor phase epitaxy, comprising the steps of:

setting a supplying rate of silicon (Si) to NH_3 in a reaction chamber during said vapor phase epitaxy at a desired value in a range from 8.6×10^{-10} to 2.6×10^{-8}, so as to control a conductivity (1/resistivity) of said gallium nitride group compound semiconductor at a desired value.

55. A method for producing a gallium nitride group compound semiconductor by an organometallic compound vapor phase epitaxy, comprising the steps of:

setting a supplying rate of silicon (Si) to gallium (Ga) in a reaction chamber during said vapor phase epitaxy at a desired value in a range from 0.1 to 3 as a converted values so as to control a carrier concentration of said gallium nitride group compound semiconductor at a desired value, where said values 0.1 and 3 are the values obtained from gas flow rates, in case that an amount of said gallium (Ga) is converted into a flow rate of hydrogen bubbling

trimethyl gallium (TMG) at a temperature of -15°C and an amount of said silicon (Si) is converted into a flow rate of a gas diluted to 0.86 ppm.

56. A method for producing a gallium nitride group compound semiconductor by an organometallic compound vapor phase epitaxy, comprising the steps of:

setting a supplying rate of silicon (Si) to NH_3 in a reaction chamber during said vapor phase epitaxy at a desired value in a range from 8.6×10^{-10} to 2.6×10^{-8}, so as to control a carrier concentration of said gallium nitride group compound semiconductor at a desired value.

57. A method for producing a gallium nitride group compound semiconductor according to claim 53, wherein said gallium nitride group compound semiconductor is $Al_XGa_{1-X}N$ ($0 \leq x \leq 1$).

58. A method for producing a gallium nitride group compound semiconductor according to claim 54, wherein said gallium nitride group compound semiconductor is $Al_XGa_{1-X}N$ ($0 \leq x \leq 1$).

59. A method for producing a gallium nitride group compound semiconductor according to claim 55, wherein said gallium nitride group compound semiconductor is $Al_XGa_{1-X}N$ ($0 \leq x \leq 1$).

60. A method for producing a gallium nitride group compound semiconductor according to claim 56, wherein said gallium nitride group compound semiconductor is $Al_XGa_{1-X}N$ ($0 \leq x \leq 1$).

Cont'd.

61. A method for producing a gallium nitride group compound semiconductor according to claim 53, wherein said gallium nitride group compound semiconductor is GaN.

62. A method for producing a gallium nitride group compound semiconductor according to claim 54, wherein said gallium nitride group compound semiconductor is GaN.

63. A method for producing a gallium nitride group compound semiconductor according to claim 55, wherein said gallium nitride group compound semiconductor is GaN.

64. A method for producing a gallium nitride group compound semiconductor according to claim 56, wherein said gallium nitride group compound semiconductor is GaN.

65. A method for producing a gallium nitride group compound semiconductor according to claim 53, wherein said conductivity (1/resistivity) is not less than 3.3/Ωcm.

66. A method for producing a gallium nitride group compound semiconductor according to claim 54, wherein said conductivity (1/resistivity) is not less than 3.3/Ωcm.

67. A method for producing a gallium nitride group compound semiconductor according to claim 57, wherein said conductivity (1/resistivity) is not less than 3.3/Ωcm.

68. A method for producing a gallium nitride group compound semiconductor according to claim 58, wherein said conductivity (1/resistivity) is not less than 3.3/Ωcm.

Q3 Cont'd.

69. A method for producing a gallium nitride group compound semiconductor according to claim 61, wherein said conductivity (1/resistivity) is not less than 3.3/Ωcm.

70. A method for producing a gallium nitride group compound semiconductor according to claim 62, wherein said conductivity (1/resistivity) is not less than 3.3/Ωcm.

71. A method for producing a gallium nitride group compound semiconductor according to claim 55, wherein said electron concentration is not less than $6 \times 10^{16}/cm^3$.

72. A method for producing a gallium nitride group compound semiconductor according to claim 56, wherein said electron concentration is not less than $6 \times 10^{16}/cm^3$.

73. A method for producing a gallium nitride group compound semiconductor according to claim 59, wherein said electron concentration is not less than $6 \times 10^{16}/cm^3$.

74. A method for producing a gallium nitride group compound semiconductor according to claim 60, wherein said electron concentration is not less than $6 \times 10^{16}/cm^3$.

75. A method for producing a gallium nitride group compound semiconductor according to claim 53, wherein said conductivity (1/resistivity) is ranging from 3.3/Ωcm to 1.3×10^2/Ωcm.

76. A method for producing a gallium nitride group compound semiconductor according to claim 54, wherein said conductivity (1/resistivity) is ranging from 3.3/Ωcm to 1.3×10^2/Ωcm.

Cont'd.

77. A method for producing a gallium nitride group compound semiconductor according to claim 57, wherein said conductivity (1/resistivity) is ranging from 3.3/Ωcm to 1.3×10^2/Ωcm.

78. A method for producing a gallium nitride group compound semiconductor according to claim 58, wherein said conductivity (1/resistivity) is ranging from 3.3/Ωcm to 1.3×10^2/Ωcm.

79. A method for producing a gallium nitride group compound semiconductor according to claim 61, wherein said conductivity (1/resistivity) is ranging from 3.3/Ωcm to 1.3×10^2/Ωcm.

80. A method for producing a gallium nitride group compound semiconductor according to claim 62, wherein said conductivity (1/resistivity) is ranging from 3.3/Ωcm to 1.3×10^2/Ωcm.

81. A method for producing a gallium nitride group compound semiconductor according to claim 55, wherein said electron concentration is ranging from $6 \times 10^{16}/cm^3$ to $3 \times 10^{18}/cm^3$.

82. A method for producing a gallium nitride group compound semiconductor according to claim 56, wherein said electron concentration is ranging from $6 \times 10^{16}/cm^3$ to $3 \times 10^{18}/cm^3$.

Cont'd.

83. A method for producing a gallium nitride group compound semiconductor according to claim 59, wherein said electron concentration is ranging from 6 x 10^{16}/cm^3 to 3 x 10^{18}/cm^3.

84. A method for producing a gallium nitride group compound semiconductor according to claim 60, wherein said electron concentration is ranging from 6 x 10^{16}/cm^3 to 3 x 10^{18}/cm^3.

85. A method for producing a gallium nitride group compound semiconductor according to claim 63, wherein said electron concentration is ranging from 6 x 10^{16}/cm^3 to 3 x 10^{18}/cm^3.

86. A method for producing a gallium nitride group compound semiconductor according to claim 64, wherein said electron concentration is ranging from 6 x 10^{16}/cm^3 to 3 x 10^{18}/cm^3.

87. A method for producing a gallium nitride group compound semiconductor according to claim 53, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

88. A method for producing a gallium nitride group compound semiconductor according to claim 54, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

Cont'd.

89. A method for producing a gallium nitride group compound semiconductor according to claim 55, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

90. A method for producing a gallium nitride group compound semiconductor according to claim 56, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

91. A method for producing a gallium nitride group compound semiconductor according to claim 57, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

92. A method for producing a gallium nitride group compound semiconductor according to claim 58, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

93. A method for producing a gallium nitride group compound semiconductor according to claim 59, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

94. A method for producing a gallium nitride group compound semiconductor according to claim 60, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

Q3 Cont'd.

95. A method for producing a gallium nitride group compound semiconductor according to claim 61, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

96. A method for producing a gallium nitride group compound semiconductor according to claim 62, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

97. A method for producing a gallium nitride group compound semiconductor according to claim 63, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

98. A method for producing a gallium nitride group compound semiconductor according to claim 64, wherein said gallium nitride group compound semiconductor is formed on or above a buffer layer which is formed on a sapphire substrate.

99. A method for producing a gallium nitride group compound semiconductor according to claim 87, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

100. A method for producing a gallium nitride group compound semiconductor according to claim 88, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

Cl 3 Cont'd.

101. A method for producing a gallium nitride group compound semiconductor according to claim 89, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

102. A method for producing a gallium nitride group compound semiconductor according to claim 90, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

103. A method for producing a gallium nitride group compound semiconductor according to claim 91, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

104. A method for producing a gallium nitride group compound semiconductor according to claim 92, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

105. A method for producing a gallium nitride group compound semiconductor according to claim 93, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

Cl 3 Cont'd.

106. A method for producing a gallium nitride group compound semiconductor according to claim 94, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

107. A method for producing a gallium nitride group compound semiconductor according to claim 95, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

108. A method for producing a gallium nitride group compound semiconductor according to claim 96, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

109. A method for producing a gallium nitride group compound semiconductor according to claim 97, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

110. A method for producing a gallium nitride group compound semiconductor according to claim 98, wherein said buffer layer is formed on said sapphire substrate by using an organometallic compound vapor phase epitaxy at a growth temperature lower than that of said gallium nitride group compound semiconductor.

Q3 Cont'd.

111. A method for producing a gallium nitride group compound semiconductor according to claim 19, wherein silicon-containing gas is silane (SiH_4).

112. A method for producing a gallium nitride group compound semiconductor according to claim 20, wherein silicon-containing gas is silane (SiH_4).

113. A method for producing a gallium nitride group compound semiconductor according to claim 53, wherein silicon-containing gas is silane (SiH_4).

114. A method for producing a gallium nitride group compound semiconductor according to claim 54, wherein silicon-containing gas is silane (SiH_4).

115. A method for producing a gallium nitride group compound semiconductor according to claim 55, wherein silicon-containing gas is silane (SiH_4).

116. A method for producing a gallium nitride group compound semiconductor according to claim 56, wherein silicon-containing gas is silane (SiH_4).

117. A method for producing a gallium nitride group compound semiconductor according to claim 63, wherein said electron concentration is not less than $6 \times 10^{16}/cm^3$.

118. A method for producing a gallium nitride group compound semiconductor according to claim 64, wherein said electron concentration is not less than $6 \times 10^{16}/cm^3$.--